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The Effects of Wage and Unemployment on Crime Incentives – An Empirical Analysis of Total, Property and Violent Crimes

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Abstract

Using quarterly data of the U.S economy and based on cointegration analysis, we built a relatively simple error correction model focusing on a few key variables that can help prove that crime is an induced response to economic incentives. In particular, we found causality summing from unemployment and wage levels to total crime in the long-run, and causality from wage to total crime in the short-run. For property crime, we found the above relationships plus a short-run causality from unemployment. Finally, violent crime seems not to be explained by economic variables.

JEL Classification: K0, K4, C32

Keywords: crime, property crime, violent crime, error correction model

I. Introduction

The economic theory of crime has experienced a great development in the last three decades. Since the seminal paper of Becker (1968), an increasing number of economists have expended efforts to understand the criminal behavior of economic agents. The general proposition is that, as with any other activity, criminal behavior is nothing more than an induced response to incentives.

Following this argument economists have tried to explain criminal behavior as a response to economic factors such as employment opportunities and individual income levels. *Ceteris paribus*, a decrease in the employment opportunities, as well as a decrease in individual income, should induce an increase in the expected returns from illegal activities.

Viewing criminal activity as a form of employment that consumes time and produces income (Witt and Tauchen 1994), a rational economic agent should compare the expected returns from legal and illegal activity beforehand to decide in which one he will engage.

This paper aims to verify whether there really is a positive relationship between crime and unemployment and income, following works like Becker (1968), Ehrlich (1973, 1975) and Cantor and Land (1985). The empirical analysis is made for total crime, plus its two subcategories, property crime and violent crime. It is based on quarterly data for the United States, from 1980 to 1998, a period chosen to avoid the increase on enforcement expenditures experienced on later years which could distort the analysis.

II. Related Literature

Following Becker's (1968) analysis and using neoclassical microeconomic principles, Ehrlich (1973; 1975) showed that there exists a positive relationship between the unemployment rate and crime. In addition, both Becker and Ehrlich state that crime rates increase as a result of a government's underinvestment in police, courts and others factors that raise the expected cost of a criminal activity.

In Phillips and Votey (1984) unemployment is associated with racial and sexual discrimination and its influence over criminal activities. They find that American black women with small children are at a disadvantage in the labor market, which constitutes an incentive to become involved in criminal activities as an option to obtain income. Thornberry and Christenson (1984) estimate a reciprocal model and conclude that there exists a reciprocal relationship between crime and unemployment. Gottfredson (1985) studied the effects of employment and school involvement over the behavior of youths and their inclination for criminal behavior. Using regression analysis the author observed that the involvement of youths with work is a factor that halts the increase of delinquency.

Cantor and Land (1985) present a rather interesting study because, contrary to other authors, they argue that unemployment does not present only one positive effect on crime. These authors point out that a complete characterization of the unemployment-crime relationship must take into consideration that unemployment presents two partial distinct effects over criminal behavior: the criminal opportunity effect and criminal motivation effect. The first and immediate effect of unemployment on crime should be negative because an increase in the unemployment rate is related to a reduction of economic activity. This means reduction in terms of production, consumption and mobility of people within the economic system. With this idea in mind, the unemployment rate can be faced as an indicator of the system's total activity. With less people and wealth circulating in the system the action of possible criminals is also reduced, because people tend to stay more at home and less on the streets.[1]

The second effect presents a positive distributed influence over time. Individuals who remain jobless for longer periods of time will probably be more inclined towards illegal activities. With the impossibility of obtaining income to maintain their standard of living with a legal traditional activity, these individuals will commit crimes as an alternative income source.

Deutsh, Hakin and Spiegel (1990) include in their analysis, in addition to crime and unemployment rates, other variables, such as expenses with the police and the level of education. Their main conclusions are: positive relationship between crime and unemployment, positive relationship between present crime and previous crimes, and a negative relationship between crime and expenses with police. In the same way, Freeman (1991) shows that there exists some kind of feedback of unemployment on crime. He argues that people who have already had any past involvement with crime, face difficulties to return to the labor market, a fact that makes them getting involved again with criminal activities.

Britt (1994) studies the effect of youth's unemployment on crime in a framework quite similar to Cantor and Land. Britt's model identifies both Cantor and Land effects for crimes against property.[2] In Witte and Tauchen (1994) education is also an important

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[1] The authors call this the "guard effect".

[2] Robbery, break through, theft.

explanatory variable jointly with unemployment. The most important conclusion of these authors is that works and school frequency are significantly related to lower levels of criminality.

Fagan and Freeman (1999) argue that the traditional exclusive relationship between crime and legal work could not be appropriate when types of crime such as employee theft, fencing, tax evasion and embezzlement, for example, are analyzed. Moreover, they say the doubling up – having a legal plus illegal jobs simultaneously - is a common practice among offenders. Hagan (1993) and Hagedorn (1994) share the same reasoning.

III. The Setup

1. The Underlying Model

The relation that provides a theoretical framework for investigating the link between crime and unemployment is:

$$C_t = f\,(C_{t-i}, U_t, U_{t-j}, W_t) \qquad (1)$$

where C_t is the number of crimes committed on time *t* and it is assumed to be a function of the past crimes (C_{t-i}), actual (U_t) and past (U_{t-j}) unemployment levels , and the actual wage (W_t).

Based on the related literature and the theoretical hypothesis, the effect of past crime in the present one is positive, which reflects both the “learning by doing” effect (Deutsh, Hakin and Spiegel, 1990) and the difficulty that a criminal may have in returning to the labor market (Freeman, 1991). The contemporaneous unemployment is expected to have an ambiguous effect on crime. This is mainly because of Cantor and Land’s “guard effect," and the decreasing of criminal opportunities caused by the reducing economic activity.

The past unemployment is also expected to have an ambiguous sign. If the past unemployment refers to a short horizon of time,[3] the various unemployment insurance programs sponsored by the government and other civil agencies could offer an alternative to crime as an income source. Moreover, as argued by Gatrell-Hadden (1962), changes in unemployment caused by business cycles are not important in determining the crime rate. On the other hand, it can be argued that an individual is "myopic" and does not consider the levels of unemployment in periods that are far away from the present. Therefore, the effect of long horizon past unemployment could be analyzed indirectly by the past crimes and the "learning-by-doing" effect.

The expected effect of wages is also ambiguous since an increase on wages can raise the expected gain from crime, which causes to have a positive effect on criminal activity. On the other hand, an increase in the wage level could induce a reduction on crime activity because the difference between the expected gain from legal and illegal activities is reduced (Becker, 1968). Moreover, an increase in the wage could reduce the doubling up activities (e.g., Fagan 1993, p. 257). In short, one could expect:

$$\partial C_t / \partial C_{t-i} > 0\,, \quad \partial C_t / \partial U_t \gtrless 0\,,$$

$$\text{and} \quad \partial C_t / \partial U_{t-j} \gtrless 0\,, \quad \partial C_t / \partial W_t \gtrless 0\,.$$

[3] One to three quarters, for instance.

The data used in the study is seasonally adjusted, quarterly, number of crimes per 100.000 inhabitants, over the period 1980 to 1998 (C_t), divided into three categories: total, property, and violent crimes; seasonally adjusted, quarterly, unemployment rate over the period 1980 to 1998 (U_t); and seasonally adjusted, quarterly, average weekly earning at 1982 prices over the period 1980 to 1998 (W_t).[4] Small letters denote log-transformed variables. The unemployment rate was subject to a logit transformation.[5]

2. Methodological Structure

We start by assuming that there is a long-run relationship between the number of crimes and economic variables such as the unemployment level and salary, whereas significant divergence between those indicators may exist in the short-run. Recent developments in time series theory may be used to analyze the long-run relationship as well as the short-run dynamics between a set of economic variables. The first step undertaken is to establish the order of integration of variables used in the model. This is accomplished by applying Augmented Dickey-Fuller (ADF) tests in each series considered in the autoregressive distributed lag (ADL) specification.

In our analysis, consider the following ADL model for crime:

$$c_t = \alpha_0 + \sum_{j=1}^{p} \alpha_j c_{t-j} + \sum_{j=0}^{r} \beta_{1j} u_{t-j} + \sum_{j=0}^{s} \beta_{2j} w_{t-j} + u_t \qquad (2)$$

where c_t denotes the crime, u_{t-j} denotes the unemployment, and w_{t-j} denotes the wage. If the order of integration of the variables in (2) are I(0), the model can be consistently

[4] The crime data was obtained at the Uniform Crime Reports from FBI. The unemployment and wage data was obtained at to Employment and Earnings, from the U.S. Bureau of Labor Statistics.

[5] This is because a rate is defined on a bounded support [0,1], and it could affect the estimations.

estimated by OLS. On the other hand, if one or of the variables are I(1), the ADL specification can be written as follows:

$$\Delta c_t = \sum_{j-0}^{r-1} \gamma_{2j} \Delta u_{t-j} + \sum_{j=0}^{s-1} \gamma_{2ji} \Delta w_{j-1} + (\alpha - 1)\{c_{t-1} - \delta_0 - \delta_1 u_{t-1} - \delta_2 w_{t-1}\} + u_t \quad (3)$$

where $\Delta c_t = c_t - c_{t-1}$, $\gamma_{kj} = \beta_{kj} / 1 - \alpha_1$, for k=1,2, and $i/\alpha_1 - 1$, for $i = \alpha_0, \beta_1, \gamma_1$

The formulation (3) is an error correction model, ECM. This specification captures both the short-run dynamic and the long-run adjustment between crime, and the other variables. The short-run dynamic is given by the differenced variables, and the long-run is given by the term in brackets involving the level non-stationary variables c_{t-1}, u_{t-1}, and w_{t-1}.

The second step in the analysis is to test for cointegration among the set of I(1) variables in the error term.[6] Johansen (1991) developed a likelihood ratio test for cointegration, which is more appropriate for a system with more than three variables as presented here. The Johansen method will be used in this study to determine the number of cointegration vectors in our system.

The last step is developing the ECM if, and only if, two or more variables are found to be cointegrated. In the ECM it is possible to include only a subset of explanatory variables, as long as the specification remains theoretically consistent. Moreover, by using the Hendry general-to-specific approach the ECM is reestimated only with the most significant parameters.[7]

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[6] One or more I(1) variables are said to be cointegrated if there exists a combination of these variables which is I(0).

[7] Note that the BIC confirms the selection of the smaller model.

IV. Econometric Tests and Estimation

1. Testing unit roots

We have tested for stationary of the data using the traditional Dickey-Fuller and augmented Dickey-Fuller (DF/ADF) tests. The results of these tests are reported in Table 1. Since the stationary tests are known to be sensitive to lag length, the optimum lag length selected in the DF/ADF tests was determined using the Schwartz Bayesian Information Criterion (BIC).[8] The DF/ADF tests indicated that the null hypothesis of a unit root couldn't be rejected for the variables in levels. Using differenced data, the computed DF/ADF tests suggest that the null hypothesis is rejected for the individual series. So, we can conclude that the series are integrated of order I(1). Table 1 shows the results.

2. Cointegration

Once we have determined that the variables are I(1), cointegration tests were performed to examine whether the variables in question have common trends. Following Johansen (1988, 1991) the maximum eigenvalue statistic, λ_{max}, is used to determine the number of cointegrating vectors. In order to implement Johansen's procedure, the following Vector Error Correction (VEC) is estimated. Let X_t be a k-dimensional vector process with lag order p+1, and a drift μ:

$$X_t = \mu + \sum_{i=1}^{p+1} A_i X_{t-i} + \gamma w_t + \varepsilon_t \qquad t = 1,...,n \qquad (4)$$

[8] The maximum number of lags is fixed at 12, and the lag that minimizes the BIC is considered the appropriate one for the variables in use.

where X_t is the (k x 1) vector of nonstationary I(1), w_t is the exogenous variable, ε_t is i.i.d. p+1-dimensional Gaussian innovation process with mean zero and nonsingular covariance matrix.[9] The process (4) can be rewritten as:

$$\Delta X_t = \mu + \pi X_{t-p} + \sum_{i=1}^{p} \pi_i X_{t-i} + \gamma w_t + \varepsilon_t \tag{5}$$

where $\pi = -\left(I - \sum_{i=1}^{p} A_i \right)$, and $\pi_i = -\left(I - \sum_{j=1}^{i} A_j \right)$

The coefficient matrix π contains information about the long-run relationship between the variables in the data vector – crime and unemployment. If the rank of π, r, is equal to zero, the impact matrix is a null vector, and the equation (5) is similar to a traditional first-differenced VAR model. If π has full rank, k, then the vector process X_t is stationary. However, if the coefficient matrix has reduced rank r < k, then there are r cointegrating vectors, which means that the matrix π can be written as $\pi = \alpha\beta'$, where both α and β are (n×r) matrices. The cointegration vectors β have the property that $\beta' X_t$ is stationary even though X_t is nonstationary. Johansen (1988) derived the likelihood ratio test statistic for the null hypothesis that there are at most r cointegrating vectors.[10] The test statistic is the trace computed as

$$T_n = -n \sum_{i=r+1}^{k} \ln(1 - \lambda_i) \tag{6}$$

where λ_i is the i^th^ largest eigenvalue.

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[9] Here, X_t is a (2×1) vector of crime and unemployment, and w_t is the wage.

[10] A more detailed discussion on the unit root and cointegration methods can be seen on Harvey (1990) and Maddala and Kim (1999).

The results in Table 2 do not reject the presence of one cointegration vector among the categories of crimes under review. This implies that there is at least one combination where all variables are cointegrated. These results support the view that unemployment significantly affects the criminal behavior in the long-run.

[INSERT TABLE 1]

[INSERT TABLE 2]

3. Error Correction Model Estimation

Table 3 presents estimates of equation (3). In the unrestricted approach the complete ECM estimates are presented. In the restricted one, just the significant parameters are included into the model. One should note first that in the property crime equation the relationship among the variables is stronger than in the violent crime equation. These findings are in accordance with most of the empirical and theoretic literature, where property crime is ranked as a kind of "illegal" work, such that it constitutes an alternative to unemployed people to get income, or to employed people to increase their income stream by doubling up.[11]

In the unrestricted models, none of the unemployment coefficients is significant. This means that in the short-run, the growth rate of unemployment has no effect on the

[11] Note that total crime is the sum of property and violent crime. Hence, the linkage between crime and unemployment/wage should be weak in the total crime equation.

growth rate of crime. This result is in accordance with the findings of Gatrell and Hadden (1967).[12]

The growth rate of crime in the previous period, Δc_{t-1}, has significant negative immediate effect on the actual growth rate of crime, which can be understood as a reduction on the propensity to crime because of the increasing on "competition" (Becker, 1968). Although the others Δc_{t-2}, Δc_{t-3}, and Δc_{t-4} are not significant, their signs support the presence of "learning-by-doing" and the difficulty to return to legality theses.

The immediate previous period growth rate of wage, Δw_{t-1}, has a significant negative effect on the growth rate of crime. This agrees with Becker's proposition of the reduction of propensity to crime, and with Fagan's reducing doubling up behavior. In other words, a lower wage induces both employed and unemployed workers to commit crime in order to increase their disposable income.

The error correction term, v_{t-1}, appeared strongly significant and with the theoretically consistent negative coefficient. This shows that crime, unemployment and wage have co-movements over time. Inside the error correction term, in total and property crime equations, the unemployment has opposite sign than crime, and wage has the same sing. All in accordance with the propositions of long-run that crime increases with unemployment and decreases with higher wages.

The restricted approach presents the same signs for the remaining significant parameters. The restricted models were found following Hendry's general-to-specific strategy. Note, however, that the BIC also selects smaller models. In the property crime

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[12] It is interesting to note that the signs of Δu_{t-1} in all categories of crime are negative. For property crime the sign of Δu_{t-2} becomes positive. Those signs are in accordance with Cantor and Land's view.

equation we found a negative significant effect of previous growth rate of unemployment on growth rate of crime, evidencing again the guard effect.

[INSERT TABLE 3]

In the restricted equations, all specification and diagnostic tests are satisfactory, reinforcing the interpretations above. The RESET statistics do not reject the models, the AR tests do not support the rejection of the null hypothesis of no serial correlation on residual, and the ARCH tests suggest that the errors are homoscedastic and independent of the regressors. In addition, the computed CUSUM (cumulative sum) of squares test has been utilized to examine parameter consistency of the ECM estimate.[13] In Figures 1,2, and 3, the null hypothesis of parameter stability cannot be rejected at 5% level of significance.

[INSERT FIGS. 1, 2, AND 3]

V. Concluding Remarks

Using quarterly data of the U.S economy and based on cointegration analysis, we built a relatively simple economic model focusing on a few key variables that can help prove that crime is an induced response to economic incentives. In particular, we found causality from unemployment and wage to total crime in the long-run, and causality from wage to total crime in the short-run. For property crime, specifically, we found the above relationships plus a short-run causality from unemployment.

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[13] The CUSUM test is based on statistic $S_t = \frac{\sum_{i=k+1}^{t} w_i^2}{\sum_{i=k+1}^{n} w_i^2}$, t = k+1, k+2, …, n; where s is the standard error of the regression fitted to all i sample, and w_i^2 is the squared recursive residuals. (Brown *at al.*, 1975)

The long-run unemployment causality seems to be in accordance with the general proposition that unemployment causes crime, which in essence means that economic agents use “illegal” work. The non-existence of a short-run positive effect could be explained by the presence of unemployment insurance programs, which drive new job losers away from criminal activities. Hence, the remaining negative short-run relationship could be attributed to the Cantor and Land’s guard effect.

The short-run relationship between wage and crime is in accordance with the doubling up proposition, and with the reduction of the expected net gain of moving from legal to illegal activities.

In this study we prove the linkage between crime and unemployment/wage, for U.S., during the period 1980-98. Although the difficulty to predict the parameter’s signs, those that we found in this analysis were in accordance with ones that we believe more reasonable.

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TABLE 1: DF / ADF UNIT ROOT TEST

Variables	Lag-Length	Intercept / Trend	DF/ADF
Levels			
Tc_t	1	Int.	0.288
Pc_t	1	Int	0.124
vc_t	2	Int	-0.587
u_t	2	Int.	-1.717
w_t	3	Int.	-1.122
First Difference			
Δtc_t	0	None	-10.589 [a]
Δpc_t	0	None	-10.835 [a]
Δvc_t	1	None	-5.957 [a]
Δu_t	0	None	-5.716 [a]
Δw_t	0	None	-8.347 [a]

[a] and [b] indicate significance at 1% and 5% level respectively.

TABLE 2: JOHANSEN COINTEGRATION TEST FOR CRIME, UNEMPLOYMENT AND WAGE

Eigenvalues	Likelihood Ratio	Critical Values 5%	Critical Values 1%	Hypothesized No. of CE(s)
Total Crime				
0.263	36.325	34.91	41.07	None [b]
0.132	14.620	19.96	24.60	At most 1
0.062	4.534	9.24	12.97	At most 2
Property Crime				
0.273	37.090	34.91	41.07	None [b]
0.138	14.448	19.96	24.60	At most 1
0.054	3.938	9.24	12.97	At most 2
Violent Crime				
0.339	36.780	34.91	41.07	None [b]
0.066	6.523	19.96	24.60	At most 1
0.020	1.483	9.24	12.97	At most 2

[a] and [b] indicate significance at 1% and 5% level respectively. Lag interval 1 to 4 for Total Crime and Property Crime, and 1 to 2 for Violnet Crime. Lags interval chosen by BIC on VAR.

TABLE 3: UNRESTRICTED AND RESTRICTED ESTIMATES OF ECMS

Indep. Variables	Dependent Variables					
	Unrestricted Approach			Restricted Approach		
	Total Crime Δc_t	Property Crime Δc_t	Vilolent Crime Δc_t	Total Crime Δc_t	Property Crime Δc_t	Vilolent Crime Δc_t
Δc_{t-1}	-0.445 [a] (0.128)	-0.334 [a] (0.123)	-0.038 (0.122)	-0.332 [a] (0.112)	-0.344 [a] (0.093)	
Δc_{t-2}	0.004 (0.134)	0.077 (0.126)	0.101 (0.117			
Δc_{t-3}	0.092 (0.132)	0.187 (0.127)			0.209[c] (0.117)	
Δc_{t-4}	0.175 (0.119)	0.245 [b] (0.119			0.292 [b] (0.110)	
Δu_{t-1}	-1.328 (1.018)	-1.282 (1.062)	-0.091 (1.248)		-1.541[c] (0.855)	
Δu_{t-2}	-0.009 (1.055)	0.147 (1.101)	-1.363 (1.107)			
Δu_{t-3}	-0.926 (1.060)	-0.548 (1.103)				
Δu_{t-4}	-1.407 (0.891)	-0.672 (0.960)				
Δw_{t-1}	-1.255 [a] (0.437)	-1.663 [a] (0.488)	-0.963 [c] (0.549)	-1.227[a] (0.380)	-1.864 [b] (0.456)	-1.240 [a] (0.455)
Δw_{t-2}	-0.554 (0.482)	-0.865 (0.548)	-0.175 (0.553)		-0.930 [b] (0.453)	
Δw_{t-3}	-0.621 (0.467)	-0.948[c] (0.527)			-1.032 [b] (0.450)	
Δw_{t-4}	-0.545 (0.479)	-0.562 (0.501)				
v_{t-1}	-0.008 [a] (0.003)	-0.152 [a] (0.058)	-0.005 (0.007)	-0.006 [b] (0.002)	-0.152 [a] (0.049)	
Statisctics:						
BIC	-4.462	-4.373	-4.120	-4.841	-4.630	-4.402
R^2	0.339	0.326	0.082	0.164	0.297	0.090
F – statistic	2.485 [0.01]	2.341 [0.01]	0.983 [0.44]	6.972 [0.00]	3.805 [0.00]	
AR(1)	3.295 [0.07]	0.684 [0.41]	0.331 [0.56]	0.121 [0.72]	0.000 [0.99]	0.039 [0.84]
AR(4)	8.775 [0.07]	5.587 [0.23]	2.259 [0.68]	4.795 [0.31]	0.098 [0.99]	1.167 [0.88]
ARCH(1)	0.003 [0.95]	0.001 [0.96]	0.003 [0.95]	0.009 [0.92]	0.104 [0.75]	0.001 [0.99]
ARCH(4)	1.314 [0.85]	1.362 [0.85]	6.118 [0.19]	4.171 [0.38]	2.251 [0.69]	6.399 [0.17]
RESET	1.015 [0.32]	0.076 [0.78]	2.352 [0.13]	0.028 [0.86]	0.156 [0.69]	0.257 [0.61]
Q(2)	1.455 [0.48]	2.586 [0.27]	0.131 [0.93]	1.358 [0.51]	0.502 [0.77]	0.944 [0.62]
Q(4)	1.542 [0.82]	2.669 [0.61]	1.221 [0.87]	5.096 [0.28]	1.040 [0.90]	1.692 [0.79]
Q(8)	2.814 [0.94]	4.509 [0.81]	6.434 [0.59]	7.598 [0.47]	3.554 [0.89]	6.640 [0.58]

Asymptotic standard errors in parentheses. [a], [b], and [c] indicate significance at 1%, 5%, and 10% level respectively. The error-correction v_{t-1} is the lagged residuals from the regression of c_t on u_t and w_t, where c_t denotes the corresponding total crime, property crime and violent crime. BIC denotes the Schwarz Bayesian Information Criterion. AR is the Breush-Godfrey LM (chi-squared) statistic n.R^2. ARCH is the Engle LM (chi-squared) statistic n.R^2. RESET (Regression Specification Test) is the Ramsey F-statistics. Q is the Ljung-Box statistics for the residuals. In AR, ARCH and Q tests, numbers in parentheses are the lags lengths. p-value significance level in brackets.

FIGURE 1. CUSUM OF SQUARES TEST FOR TOTAL CRIME

Unrestricted model Restricted model

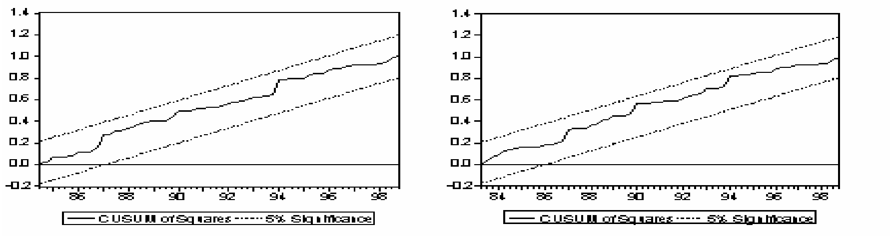


Figure 2. CUSUM of squares test for Property Crime
Unrestricted model Restricted model

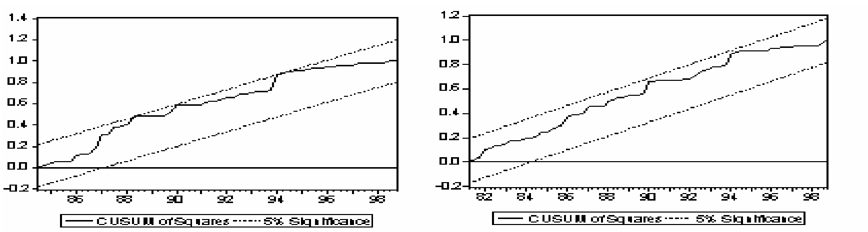
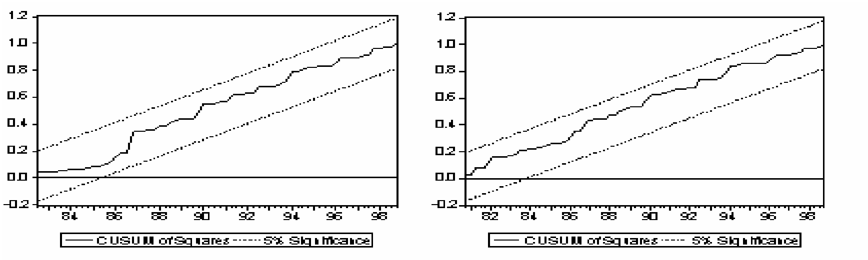


Figure 3. CUSUM of squares test for Violent Crime
Unrestricted model Restricted model



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